

# The Biological Condition Gradient- Monitoring changes in fish assemblage structure in response to stressors

An example that evaluates a fish BCG and stressors using data collected from the Appalachian Mountains of VA and WV.

Lou Reynolds and Greg Pond – EPA Region 3 – Freshwater Biology Team

Emma Jones and Jason Hill - VADEQ



# Disclaimer

**The following presentation is based on views of the authors and is not necessarily endorsed by the U.S. EPA or the Federal Government.**



# Acknowledgments

Marc Weber – EPA ORD – Corvallis ran IWI scores and ICI scores for fish BCG sites in the dataset and collaborated on the use of that analysis.

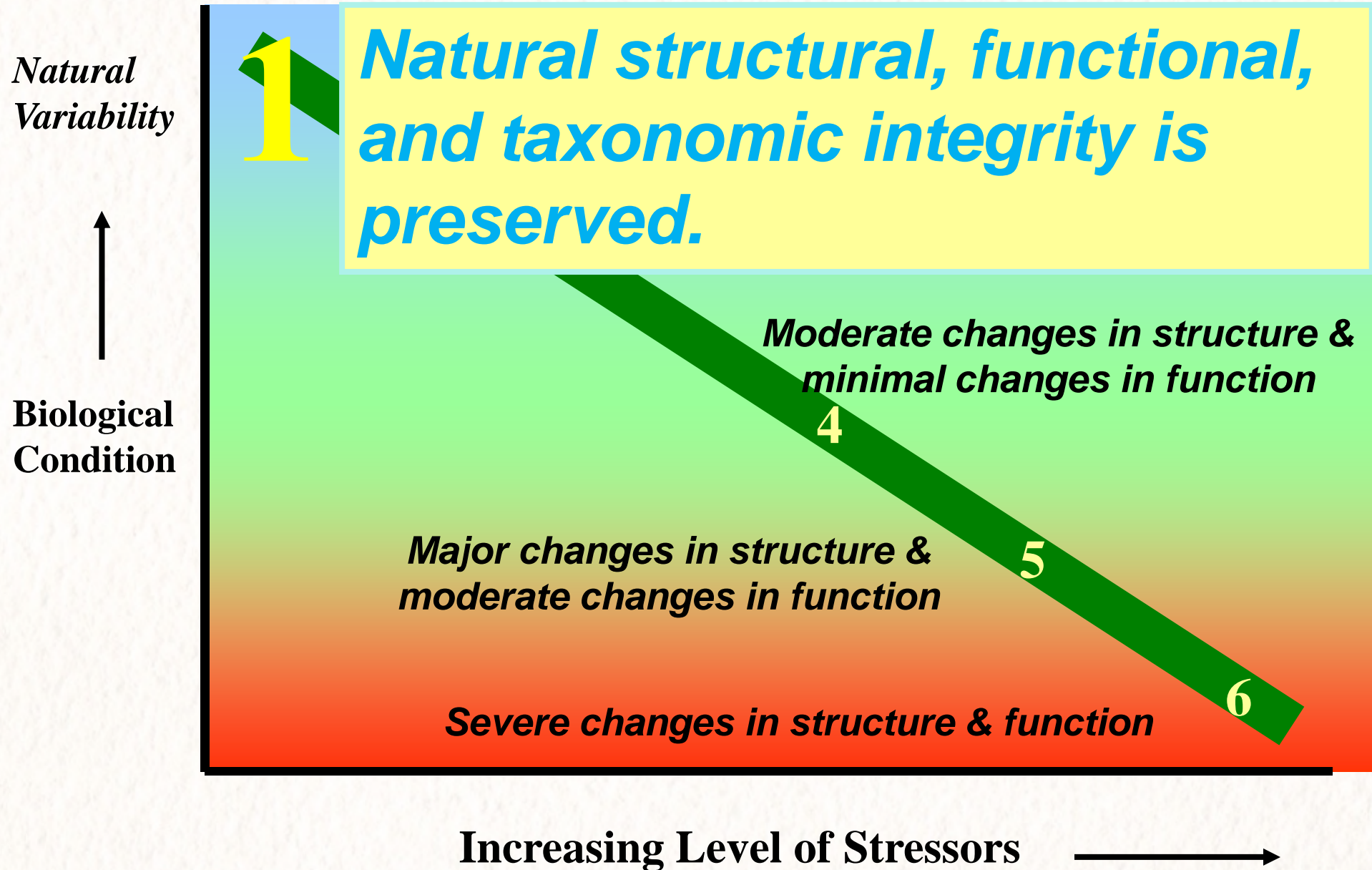
Thanks to all the fish squeezers who collected this data.



# The Biological Condition Gradient (BCG)

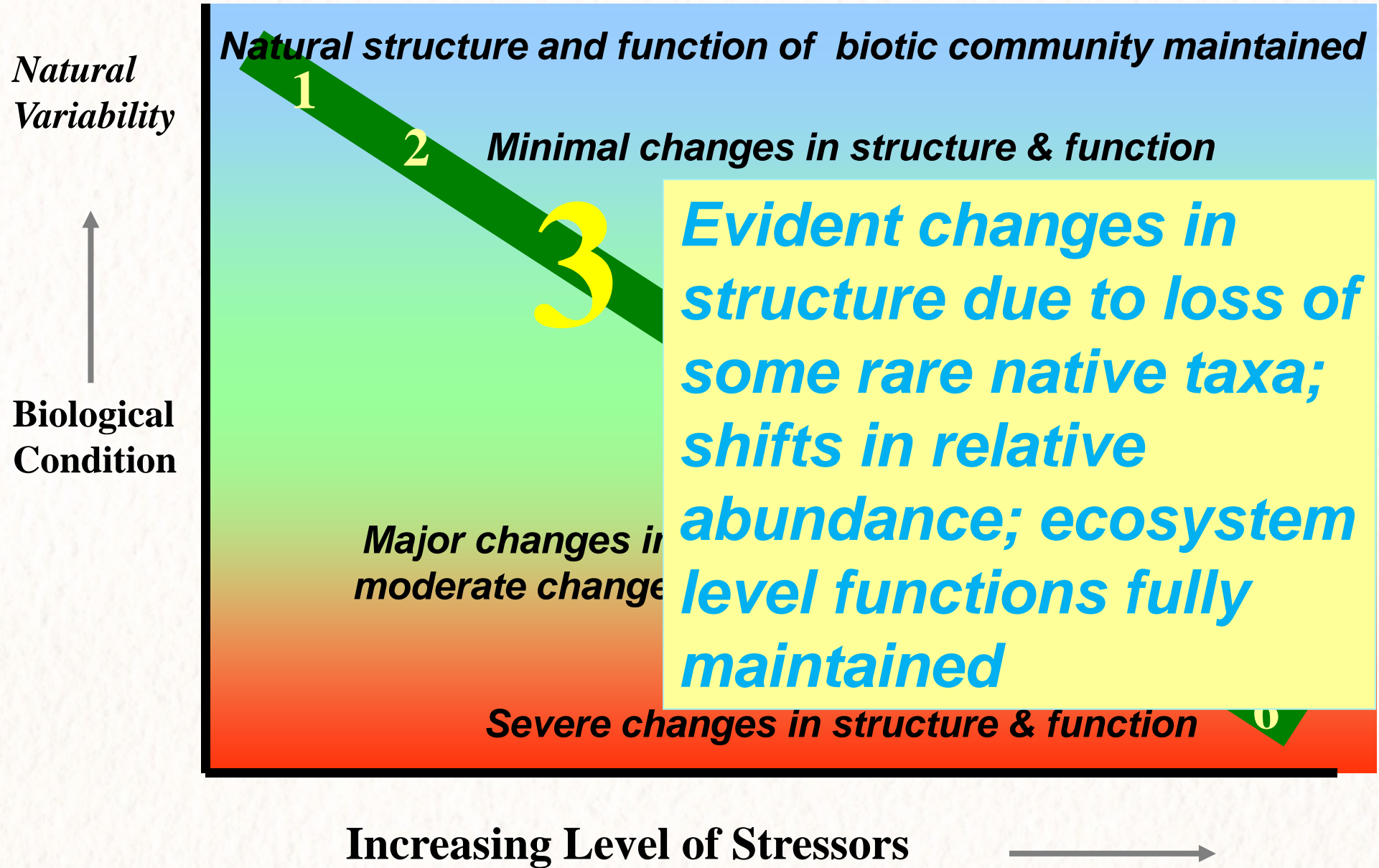
- Conceptual model of aggregated biological knowledge to describe changes with increasing stress
- Based on combination of ecological theory and empirical knowledge
- Creates a complete scale (1–6), and consistent interpretation of biological condition

# Conceptually, the Biological Condition Gradient

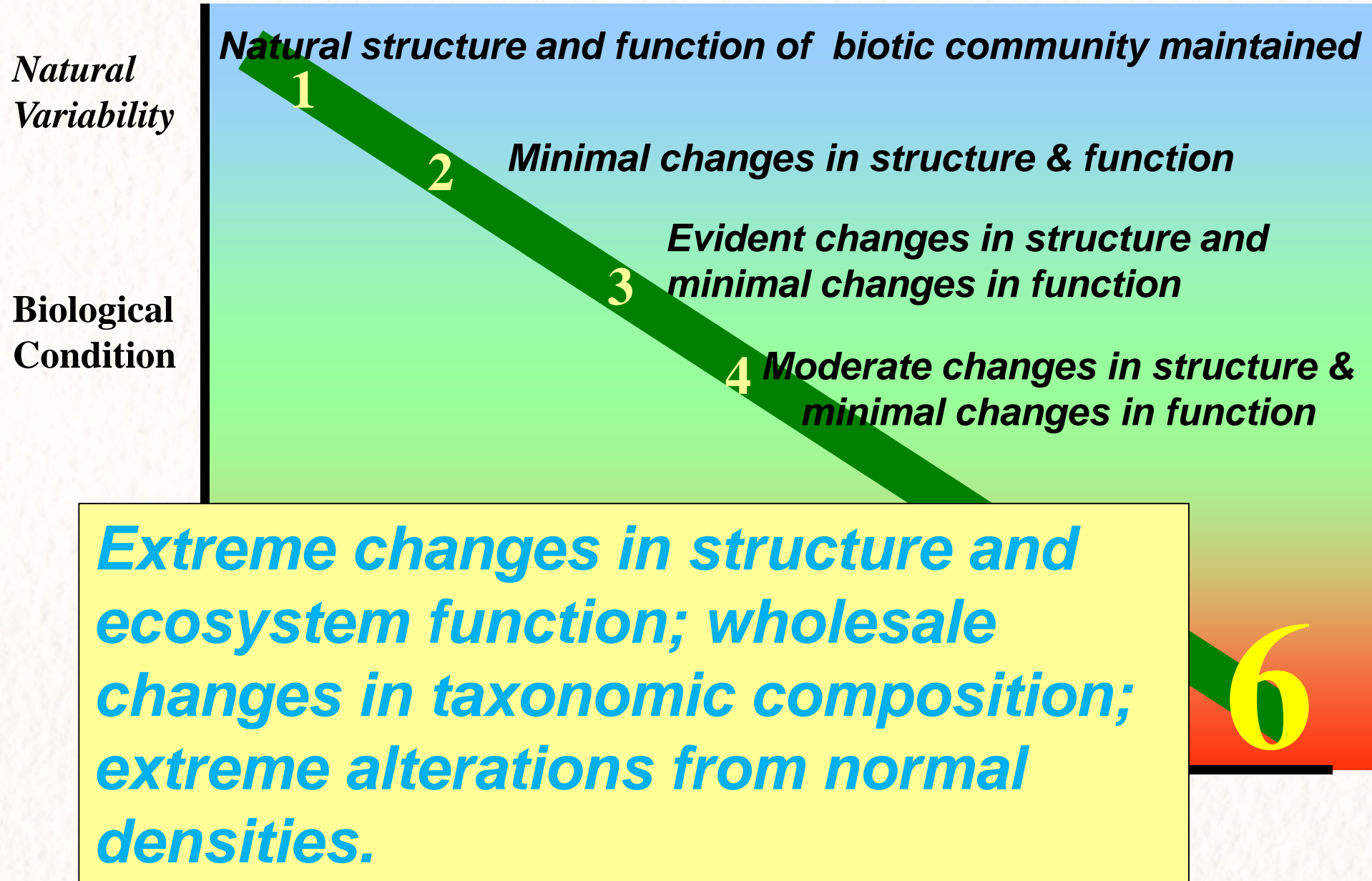




# The Biological Condition Gradient



# The Biological Condition Gradient



# Taxon Attributes (I-VI)

**I. Historically documented, sensitive, long-lived, regionally endemic taxa**

**II. Highly sensitive or specialist taxa**

**III. Sensitive and common taxa**

**IV. Taxa of intermediate tolerance**

**V. Tolerant taxa**

**VI. Non-native taxa**

**VII. Organism condition**

**VIII. Ecosystem Function**

**IX. Spatial and temporal extent of detrimental effects**

**X. Ecosystem Connectivity**



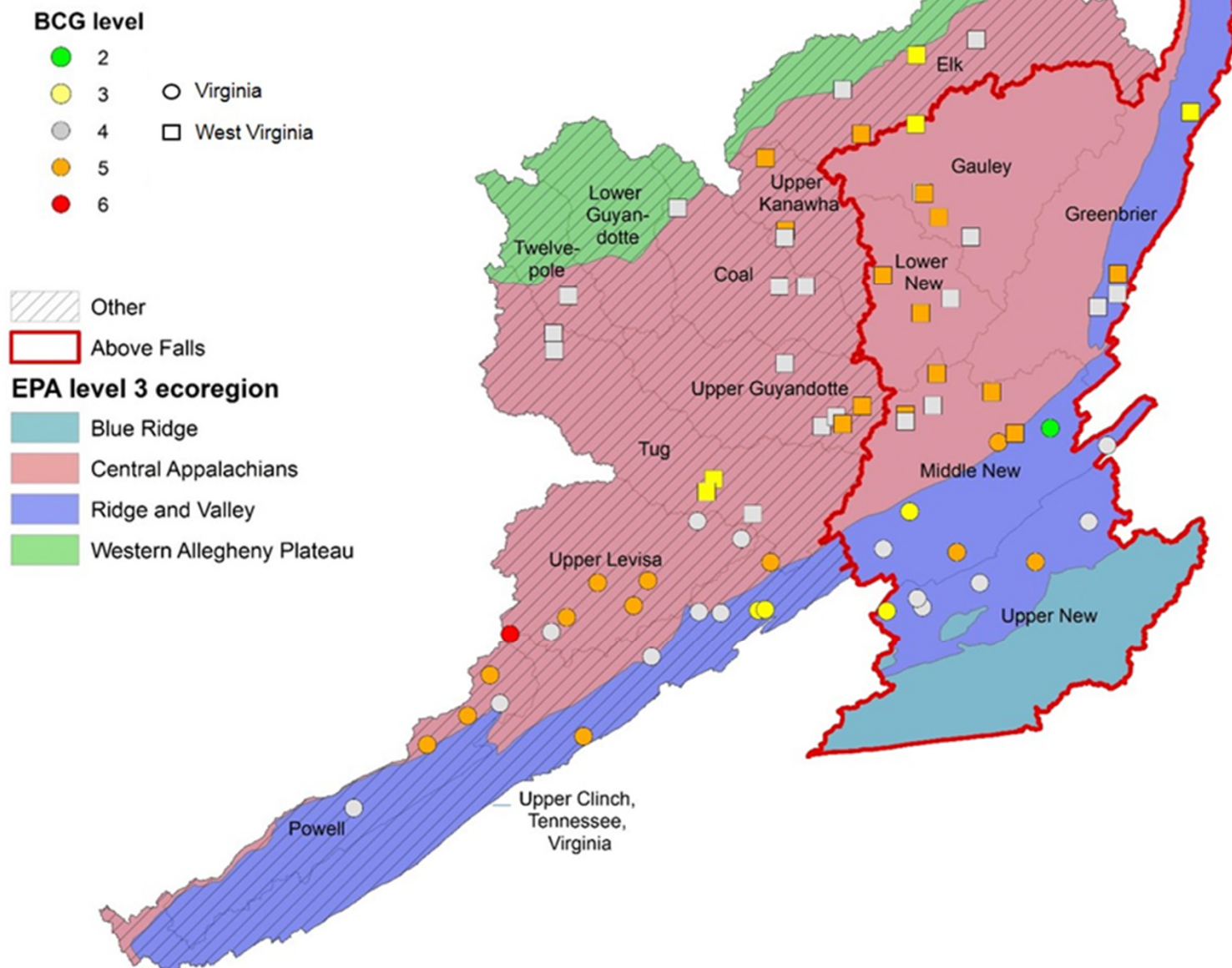


Figure 10 from: Jessup, Ben, and Jen Stamp. 2016. Calibration of the Biological Condition Gradient (BCG) for Fish and Benthic Macroinvertebrate Assemblages in the Central Appalachians DRAFT REPORT. Prepared for VA DEQ by TetraTech Inc.



That's just, like, you know, your opinion, man.  
- Jeff Lebowski





# BCG requires expert opinion and facilitated discussion

Expert Wranglers:

**Jen Stamp and Ben Jessup** – Tetra Tech

Fish Experts:

Lou Reynolds - USEPA

Frank Borsuk - USEPA

Dan Cincotta – WVDNR

Than Hitt – USGS

Jason Morgan – WVDEP

Ryan Pack – WVDEP

Jason Hill – VADEQ

Rick Browder - VADEQ

Royce Steiner - VADEQ

Brett Stern - VADEQ

Scott Hasinger – VADEQ

Royce Steiner – VADEQ


Data Wrangler:

**Emma Jones** - VADEQ

BCG Att	Number of Taxa	Count	PctTax	PctInd		
1	0	0	0.00	0.00		
2	1	19	0.143	0.4318	Source	VA_67
3	2	15	0.286	0.3409	Basin	Middle New
4	1	1	0.143	0.0227	StationID	
5	2	7	0.286	0.1591	Stream_Name	
6i	0	0	0.00	0.00	Catchment (mi²)	9.21
6m	1	2	0.143	0.0455	Catchment (km²)	23.87
6t	0	0	0.00	0.00	Order	2.00
10	0	0	0.00	0.00	Dist_Confl_km	
x	0	0	0.00	0.00	Order_Conf	
	0	0	0.00	0.00	Connected	
	0	0	0.00	0.00	Duration_sec	1000.00
Total	7	44	1.00	1.00	ReachLength_m	200.00
					NumDevices_WV	

BCG Att	Common Name	Scientific Name	Count	Family	Elevation_ft	983.09
2	brook trout	Salvelinus fontinalis	19	SALMONIDAE		Perennial
3	mottled sculpin	Cottus bairdii	2	Cottidae	LCC class	Runoff...
3	rosyside dace	Clinostomus funduloides	13	Cyprinidae	Conductivity	
4	fantail darter	Etheostoma flabellare	1	Percidae	(mS/cm)	NA
5	central stoneroller	Campostoma anomalum	1	Cyprinidae	RBP, Total Habitat	
5	western blacknose dace	Rhinichthys obtusus	6	Cyprinidae	Score	NA
6m	bluehead chub	Nocomis leptcephalus	2	Cyprinidae		



BCG_model	Panelist	Panel_Agree	BCG Att	Common Name	TOTAL
Above_Falls	2-	solid 2-; eight 2s, two 3s	1	candy darter	15
			3	longnose dace	13
			3	mottled sculpin	26
			3	rosyside dace	31
			3	torrent sucker	19
			4	fantail darter	24
			4	Mountain redbelly dace	18
			4	northern hog sucker	1
			5	central stoneroller	27
			5	creek chub	4
			5	crescent shiner	2
			5	western blacknose dace	3
			5	white sucker	1
			6m	bluehead chub	19
			6m	brown trout	1
			6m	rainbow trout	1

Panelist					BCG Att		Common Name		TOTAL	
BCG_model	PlusMinus	Panel_Agree								
Above_Falls	2-	solid 2-; eight 2s, two 3s			1		candy darter		15	
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					4		fantail darter		24	
					4		Mountain redbelly dace		18	
					4		northern hog sucker		1	
					5		central stoneroller		27	
					5		creek chub		4	
					5		crescent shiner		2	
					5		western blacknose dace		3	
					5		white sucker		1	
					6m		bluehead chub		19	
					6m		brown trout		1	
					6m		rainbow trout		1	
BCGmodel					BCGmodel					
BCGmodel	primary	second	BCGmodel							
primary	membership	membership	second	close?						
3	1		0							



BCG_model	Panelist	Panel_Agree	BCG Att	Common Name	TOTAL
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Above\_Falls                      5-                      solid 5-; eight 5s (mostly -s), two 6+s

5	Creek Chub	25
5	Western Blacknose Dace	11
6t	Bluegill	5
6t	Green Sunfish	15
6t	Largemouth Bass	1

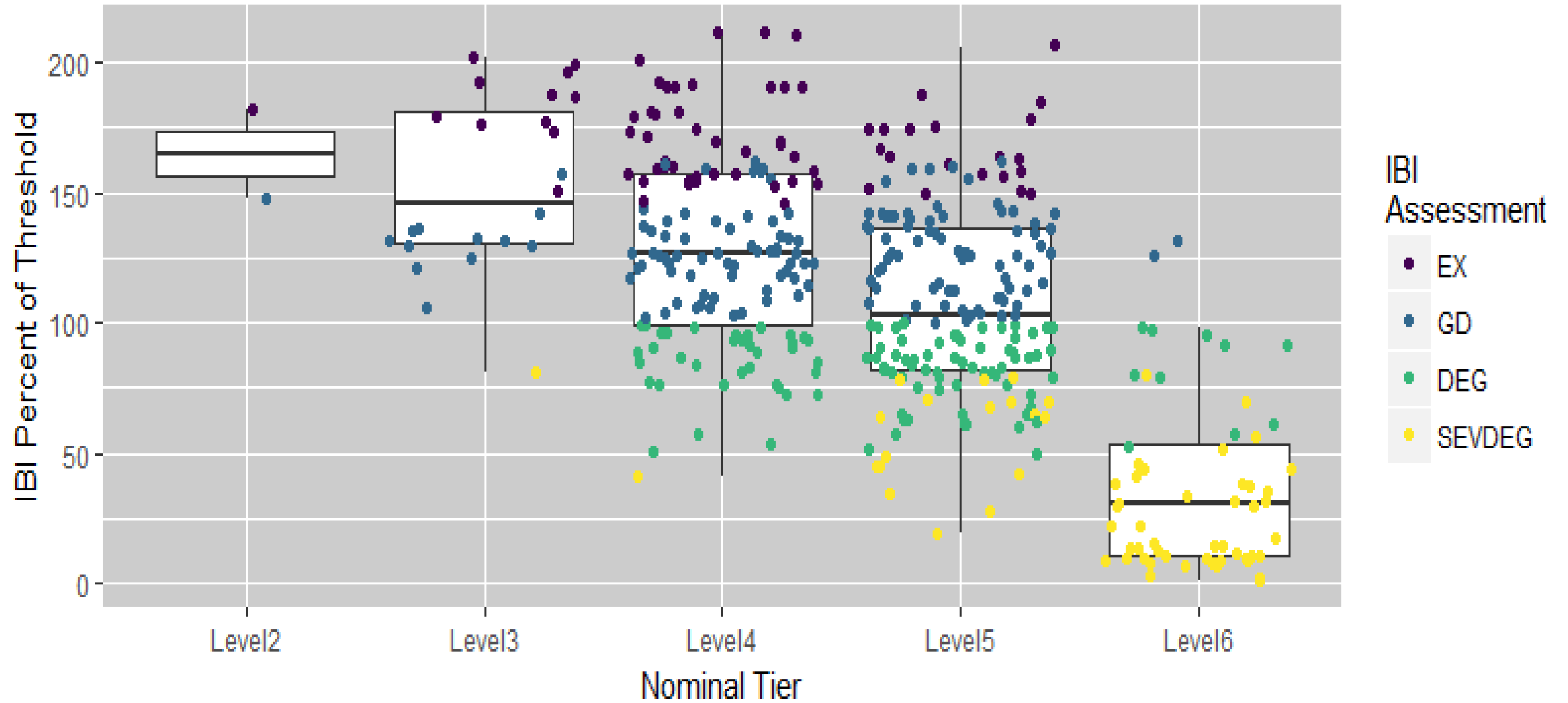


					Panelist						
BCG_model		PlusMinus		Panel_Agree				BCG Att	Common Name	TOTAL	
Above_Falls					5-		solid 5-; eight 5s (mostly -s), two 6+s		5	Creek Chub	25
									Western Blacknose		
									5	Dace	11
									6t	Bluegill	5
BCGmodel		BCGmodel		BCGmodel				6t	Green Sunfish	15	
primary	membership	membership	second	close?					6t	Largemouth Bass	1
5	0.7	0.3	6								



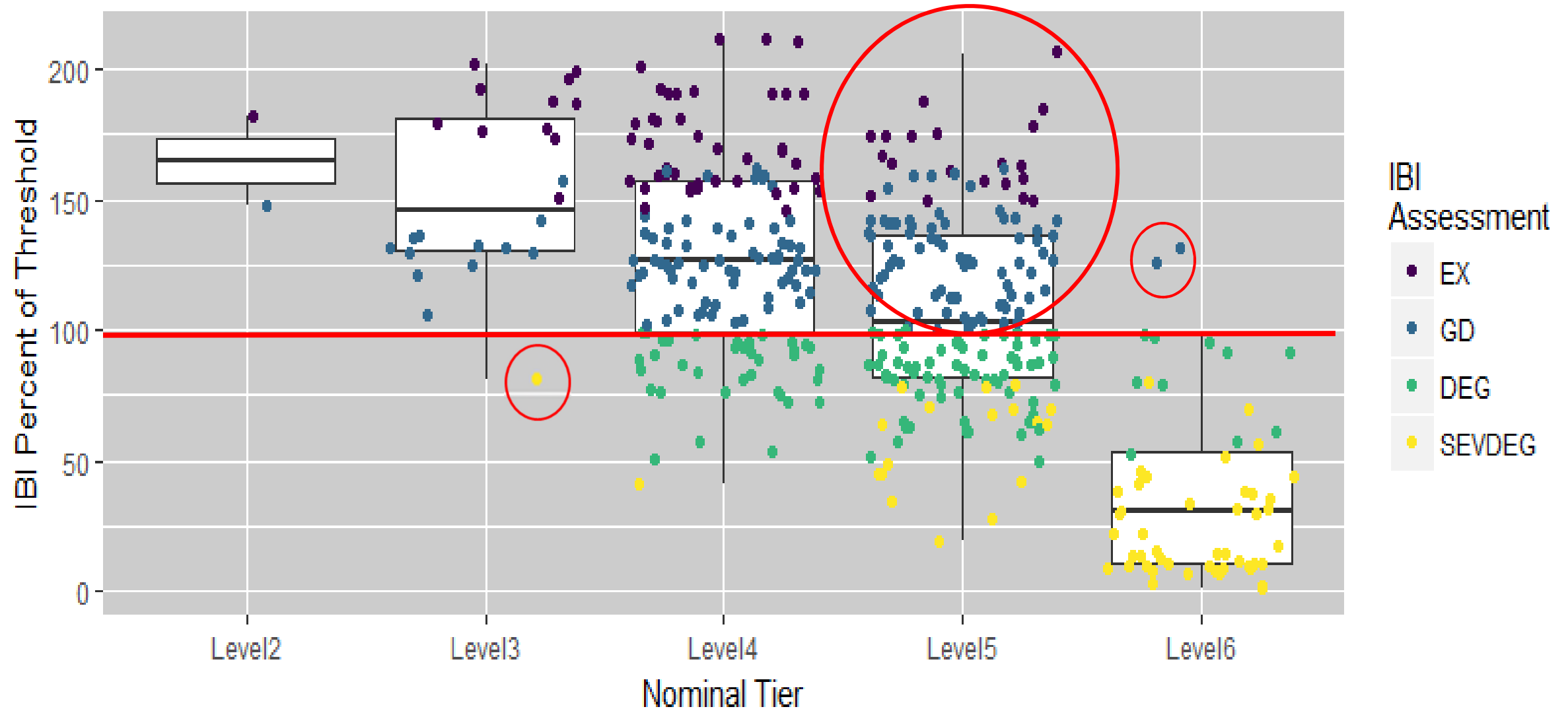
# Central Appalachian Streams

West Virginia IBI by BCG Tier



# Central Appalachian Streams

West Virginia IBI by BCG Tier





# Central Appalachian Streams

WV BCG Nominal levels across disturbance



# The fish-smash dataset

- Virginia DEQ starts a project to re-assign attribute values to fish and macroinvertebrates by amassing a multi-agency dataset of taxa x stressor.
  - No small feat as both the taxa and stressors vary by agency. Go see Jason and Emma's poster for the details.
- This dataset has thousands of sites throughout VA, WV, and MD
- To look at the fish BCG response to stress required choosing those sites that fell within the Appalachian Mountains and running the model on those – with stressors as part of the dataset – 749 sites
- Index of Watershed Integrity (IWI) values joined to the stressor and BCG datasets . IWI values calculated as in Thornbrugh et al. 2018

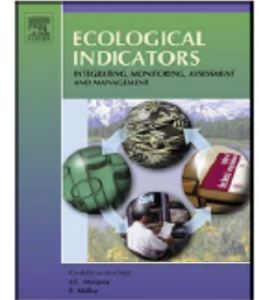




Contents lists available at ScienceDirect

## Ecological Indicators

journal homepage: [www.elsevier.com/locate/ecolind](http://www.elsevier.com/locate/ecolind)



Research paper

### Mapping watershed integrity for the conterminous United States

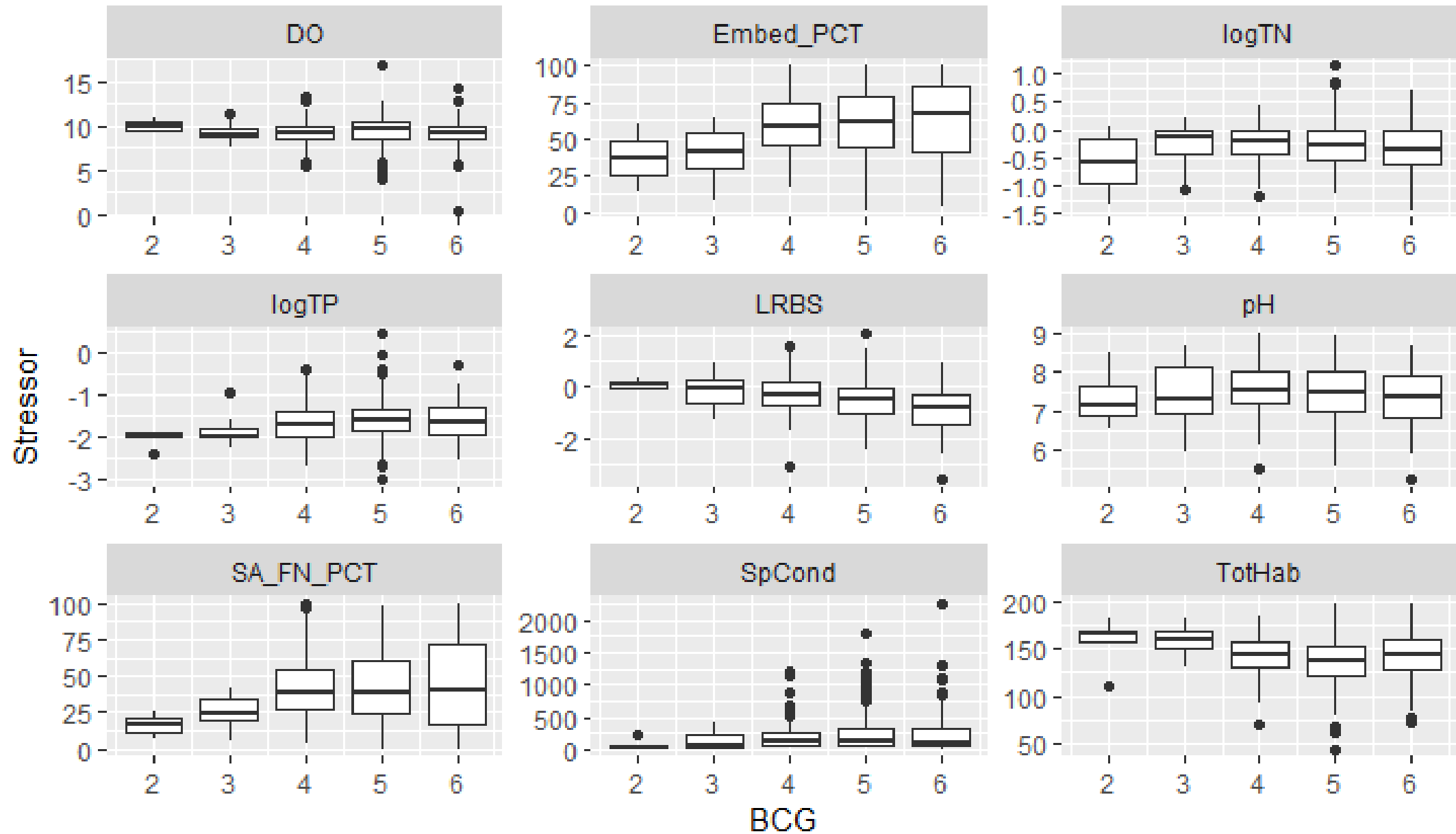
Darren J. Thornbrugh<sup>a,1</sup>, Scott G. Leibowitz<sup>b,\*</sup>, Ryan A. Hill<sup>a</sup>, Marc H. Weber<sup>b</sup>,  
Zachary C. Johnson<sup>a</sup>, Anthony R. Olsen<sup>b</sup>, Joseph E. Flotemersch<sup>c</sup>, John L. Stoddard<sup>b</sup>,  
David V. Peck<sup>b</sup>

<sup>a</sup> Oak Ridge Institute for Science and Education (ORISE) Post-Doctoral Fellow c/o U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Western Ecology Division, 200 SW 35th St., Corvallis, OR 97333, USA

<sup>b</sup> U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, 200 SW 35th St., Corvallis, OR 97333, USA

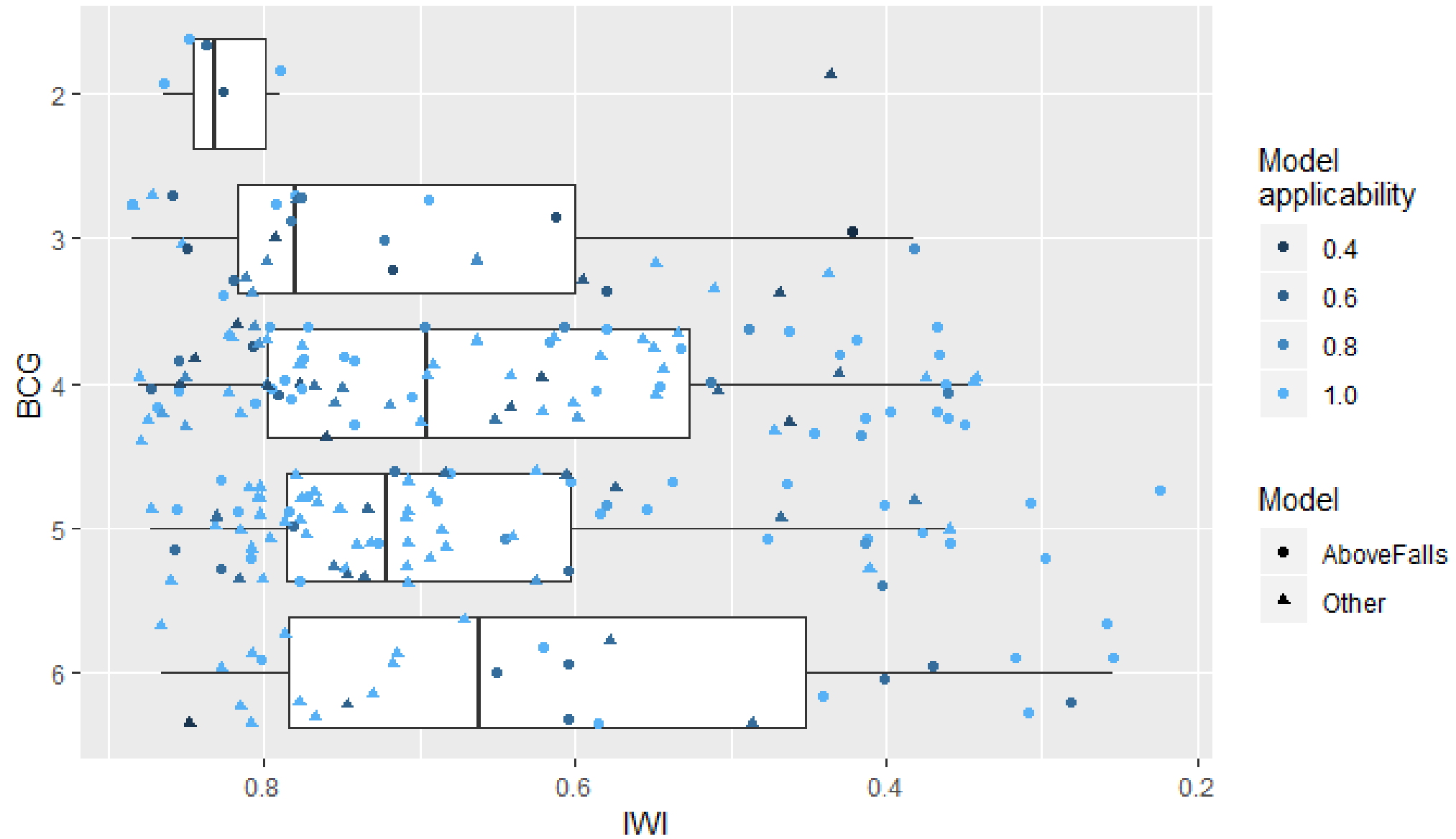
<sup>c</sup> U.S. Environmental Protection Agency, National Exposure Research Laboratory, 26 W. Martin Luther King Dr., Cincinnati, OH 45268, USA

## BCG and stressors

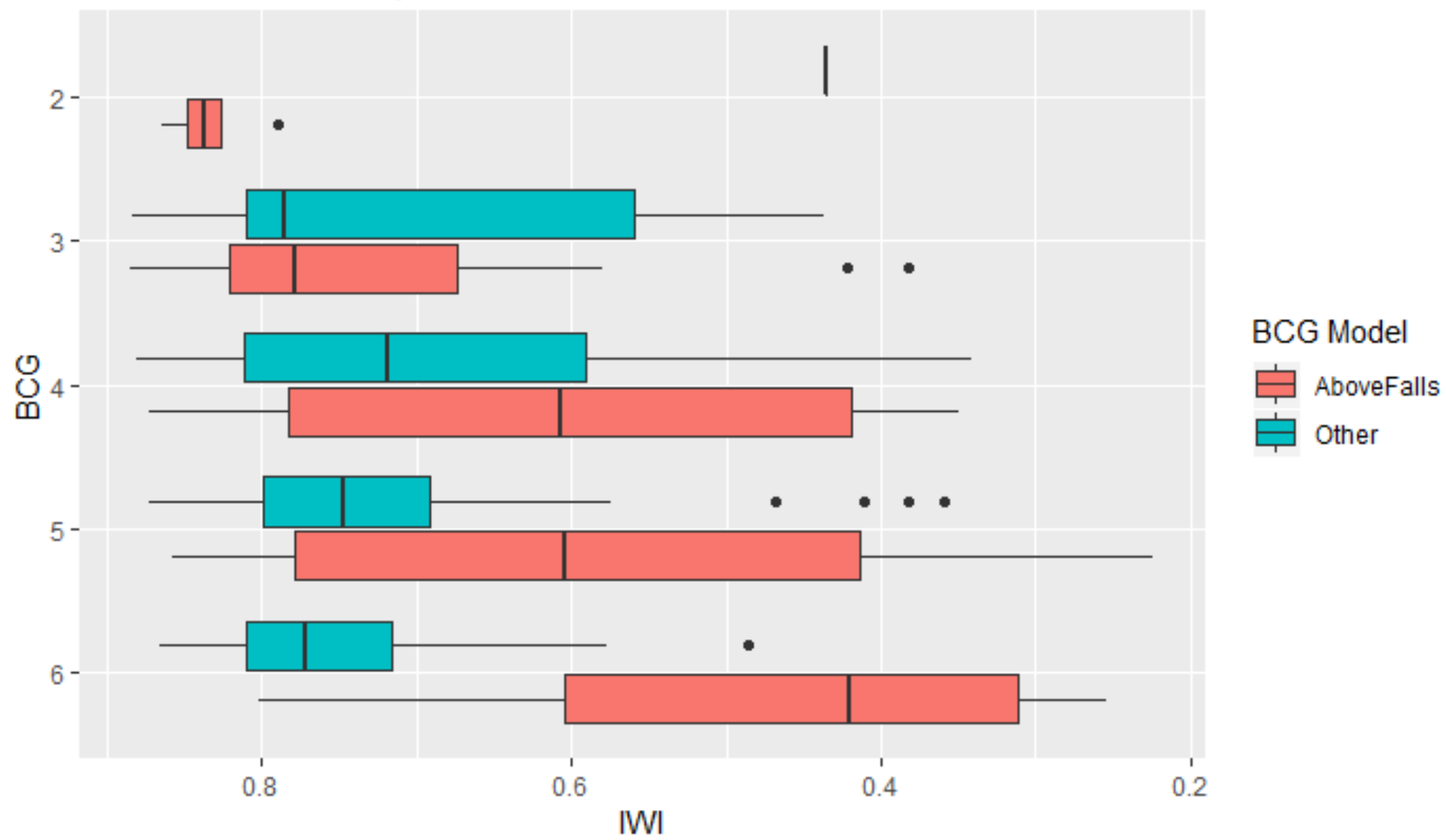




## BCG and the IWI



BCG and the IWI by BCG model





## Next Steps

- Keep looking at different combinations of stressors and how fish and macroinvertebrates respond to them
- Now that all the fish have been re-attributed, we need to summarize any changes.
- Re-run the BCG models to determine if attribute changes affect the model and how.
- Re-score previously scored sites and new sites to re-calibrate the model.



- Continue to look at the BCG over stressor gradients. The lack of a response may not indicate a failure of the BCG model and concept, but might be a misunderstanding of what stressors are important to fish or macroinvertebrates.
- We should question both axes. The concept of IWI offers some insight in how we might combine stressors. We should keep doing this. Different combinations of stressors might be important.